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Ionization of Methane, Ethane, Butane and Octane in Strong and Ultrastrong, Relativistic Fields SASIKUMAR PALANIYAPPAN, ROBERT MITCHELL, ROBERT SAUER, ISAAC GHEBREGZIABHER, SAMANTHA WHITE, MATTHEW DECAMP, BARRY WALKER, University of Delaware — Strong and ultrastrong field photoionization of methane is reported at intensities from 10^{14} W/cm^2 to 10^{19} W/cm^2. The molecular fragment ions, C^+, and C^{+2} are created in an intensity window from 10^{14} W/cm^2 to 10^{15}W/cm^{2}and show a high degree of correlation generally consistent with a Coulomb explosion mechanism. The ionization of the remaining valence electrons in carbon (C^{+3}, C^{+4}) has at least two contributing mechanisms, one correlated to the molecular fragments and one resulting from tunneling ionization of the carbon ion. The photoelectron energy spectrum near the saturation intensity of C^{+4} extends out to 1 keV. In ultrastrong fields (10^{19}W/cm^2), removal of the K-shell to form C^{+5} is uncorrelated with molecular channels. The ionization proceeds via tunneling and non-sequential rescattering ionization. The photoelectron energy spectrum for C^{+5} is shown to extend beyond the rest mass of the electron with kinetic energies up to 0.6 MeV. We also measured C^{+n} (n<5) ion yields from ethane, butane and octane at intensities from 10^{14}W/cm^{2}to 10^{17} W/cm^{2}from a linearly polarized field. These results are very similar to that from methane, which strongly indicates that the response of methane to an ultrastrong laser field can be generalized to even larger molecules.

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